DLP-2232MSPF
LEAD FREE

USB / MICROCONTROLLER MODULE

The DLP-2232MSPF combines the same USB interface used in the DLP-2232H and the DLP-1232H modules with a Texas Instruments microcontroller with internal FRAM to form a rapid development tool. The MSP430FR5739 microcontroller is preprogrammed with basic functionality for accessing the port pins and can be reprogrammed with user firmware via a 12-pin header using the MSP-FET430UIF device programmer/debugger (purchased separately).

FEATURES:

- The DLP-2232MSPF module utilizes a Texas Instruments 16-bit RISC architecture processor with 16K bytes FRAM, 1K bytes RAM and a multi-channel,10-bit A/D converter
  - Up to 24MHz operation
  - Ultra low power FRAM operates as unified memory and is configurable as code, data or storage memory
  - FRAM write access and code execution at up to 24MHz
  - FRAM has virtually unlimited write endurance (10^{14} cycles)
  - FRAM is inherently secure and radiation resistant

- The DLP-2232MSPF has 26 digital I/O lines available for interfacing to user electronics via a compact, 40-pin DIP footprint module (12 can be configured as A/D inputs)

- Send/receive data over a high-speed USB 2.0 interface to a host computer at 1M baud (921600)

- Required 5V power supply can be taken directly from the USB port or supplied by user electronics

- "Token I/O" code is preprogrammed into the MSP430FR5739's FRAM memory for basic port pin input/output capability including access to the A/D converter

- The FRAM memory can be easily erased and reprogrammed utilizing a user-supplied compatible programmer or a user-supplied internal bootstrap loader through UART UCA0

- No in-depth knowledge of USB is required as all USB protocols are handled automatically by the on-board FT2232H and its support circuitry

  - Royalty-free device drivers eliminate the need for USB driver development in most cases
  - USB bulk or isochronous data-transfer modes
  - USB 1.1 and USB 2.0 compatible
  - USB VID, PID, serial number and product-description strings are stored in on-board EEPROM memory

APPLICATION AREAS:

- Prototype development
- USB ISDN and ADSL modems
- USB interface for digital cameras
- USB interface for MP3 players
- High-speed USB instrumentation
- USB smart-card readers
- Set top box (STB) PC-USB interface
- USB hardware modems
- USB wireless modems
- USB bar code readers

1.0 GENERAL DESCRIPTION

The DLP-2232MSPF provides a cost-effective, microcontroller-based method of interfacing an electronic peripheral to a host computer via USB.

To send data from the peripheral to the host computer, the microcontroller simply writes data into the FT2232H on its RXD pin at 1M baud. Commands and data sent from the host are transferred serially on the TXD pin.

By using FTDI's Virtual COM Port Drivers, the peripheral looks like a standard COM port to the application software. The latest versions of the drivers are available for download from DLP Design's website at **www.dlpdesign.com**.

2.0 DRIVER SOFTWARE

FTDI's VCP (Virtual COM Port) driver-executable files are provided royalty free on the condition that they are used only with designs incorporating an FTDI device (i.e. the FT2232H on the DLP-2232MSPF). The latest version of the drivers can be downloaded from **www.dlpdesign.com** or **www.ftdichip.com**.

The VCP driver download file is a combined set of drivers for Windows 7, Windows Vista and Windows 2000/XP. Unzip the file to a blank floppy disk or folder on your PC. (The drivers can coexist on the same floppy disk or folder since the INF files determine which set of drivers to load for each operating system version.) Once loaded, the VCP drivers allow the application software running on your host PC to communicate with the DLP-2232MSPF as though it were connected to a COM (RS-232) port.

In addition to VCP drivers, FTDI's D2XX direct drivers offer an alternative solution to the VCP drivers that allow application software to interface with the DLP-2232MSPF using a DLL instead of a Virtual COM Port. The architecture of the D2XX drivers consists of a Windows WDM driver that communicates with the device via the Windows USB stack and a DLL that interfaces the application software (written in VC++, C++ Builder, Delphi, VB, etc.) to the WDM driver.

The D2XX direct drivers add support for simultaneous access and control of multiple FT2232H devices. The extended open function (FT_OpenEx) allows the device to be opened by either its product description or serial number, both of which can be programmed to be unique. The List

Devices function (FT_ListDevices) allows the application software to determine which devices are currently available for use, again by product description or by serial number.

Download FTDI Application Notes AN232-03, AN232-05, AN232-06 and AN232-07 for detailed instructions on how to install and remove the drivers.

3.0 EEPROM WRITE UTILITY

The DLP-2232MSPF has the option to accept manufacturer-specific information that is written into on-board EEPROM memory. Parameters that can be programmed include the VID and PID identifiers, the manufacturer's product string or a serial number.

MPROG is an EEPROM serializer from FTDI for the FT2232H device. MPROG is based on the new D2XX drivers and will work on Windows 7, Windows Vista and Windows 2000/XP platforms.

You must install the latest release of the CDM drivers in order to run this application. (Refer to the MPROG User's Guide for details on the program's use.)

4.0 QUICK START GUIDE

This guide requires the use of a Windows 7/Vista/2000/XP PC that is equipped with a USB port.

1. Download the WHQL-certified CDM device drivers from either **www.dlpdesign.com** or **www.ftdichip.com**. Unzip the drivers onto a blank floppy disk or into a folder on the hard drive.

    Note: The DLP-2232MSPF can be configured to receive its operating power from the USB port or from user electronics. Pins 19 and 20 allow for this configuration. (Refer to the Pinout Description in the next section for details on the DLP-2232MSPF electrical interface.)

     The board will not operate until a power source has been connected.

2. Connect the DLP-2232MSPF board to the PC via a standard A-B, 6-foot USB cable. This action initiates loading of the USB drivers. When prompted, select the folder where the CDM device drivers were stored in Step 1. Windows will then complete the installation of the device drivers for the DLP-2232MSPF board. The next time the DLP-2232MSPF board is attached, the host PC will immediately load the correct drivers without any prompting. Reboot the PC if prompted to do so.

    The DLP-2232MSPF is shipped with default VID, PID, etc. values programmed into the EEPROM memory. You only need to run MPROG if you want to change the default values.

At this point, the DLP-2232MSPF is ready for use. Note that the DLP-2232MSPF will appear non-responsive if data sent from the host PC is not read from the FT2232H device by the MSP430FR5739 microcontroller. The token firmware with which the DLP-2232MSPF comes preloaded will read data sent by the host by default. Custom user firmware should also follow this protocol.

5.0 TOKEN I/O

The MSP430FR5739 microcontroller on the DLP-2232MSPF comes preprogrammed with firmware that provides rudimentary access to the port pins via either the VCP or DLL drivers. Features include the ability to read and write individual port pins.

The firmware in the DLP-2232MSPF also provides access to the MSP430FR5739's A/D converter and communications. Commands sent to the Token I/O firmware must adhere to a specific communications protocol. Each command sequence contains the following information:

> **Byte 0:**   **Number of bytes in command sequence**
> **Byte 1:**   **Command**
> **Byte 2…n:**   **Parameter/data bytes**

For example, setting Port Pin P1.1 high would require the following string of bytes:

0x05, 0x30, 0x11, 0x00, 0x01

Definition of the Bytes:

0x05 – Number of bytes in command
0x30 – Command for digital port-pin access
0x11 – Affected port pin
0x00 – Set port pin to output
0x01 – Desired state of port pin

The port pins equate to hexadecimal numeric constants as defined here:

PORT 1:

0x10 = P1.0 MSP430FR5739 Pin 1, DLP-2232MSPF module Pin J1.2
0x11 = P1.1 MSP430FR5739 Pin 2, DLP-2232MSPF module Pin J1.1
0x12 = P1.2 MSP430FR5739 Pin 3, DLP-2232MSPF module Pin J1.4
0x13 = P1.3 MSP430FR5739 Pin 8, DLP-2232MSPF module Pin J1.5
0x14 = P1.4 MSP430FR5739 Pin 9, DLP-2232MSPF module Pin J1.6
0x15 = P1.5 MSP430FR5739 Pin 10, DLP-2232MSPF module Pin J1.7
0x16 = P1.6 MSP430FR5739 Pin 28, DLP-2232MSPF module Pin J1.35
0x17 = P1.7 MSP430FR5739 Pin 29, DLP-2232MSPF module Pin J1.34

PORT 2:

0x22 = P2.2 MSP430FR5739 Pin 23, DLP-2232MSPF module Pin J1.26
0x23 = P2.3 MSP430FR5739 Pin 34, DLP-2232MSPF module Pin J1.38
0x24 = P2.4 MSP430FR5739 Pin 35, DLP-2232MSPF module Pin J1.39
0x27 = P2.7 MSP430FR5739 Pin 33, DLP-2232MSPF module Pin J1.37

PORT 3:

0x30 = P3.0 MSP430FR5739 Pin 4, DLP-2232MSPF module Pin J1.17
0x31 = P3.1 MSP430FR5739 Pin 5, DLP-2232MSPF module Pin J1.16
0x32 = P3.2 MSP430FR5739 Pin 6, DLP-2232MSPF module Pin J1.14
0x33 = P3.3 MSP430FR5739 Pin 7, DLP-2232MSPF module Pin J1.15
0x34 = P3.4 MSP430FR5739 Pin 24, DLP-2232MSPF module Pin J1.28
0x35 = P3.5 MSP430FR5739 Pin 25, DLP-2232MSPF module Pin J1.30
0x36 = P3.6 MSP430FR5739 Pin 26, DLP-2232MSPF module Pin J1.29
0x37 = P3.7 MSP430FR5739 Pin 27, DLP-2232MSPF module Pin J1.31

PORT 4:

0x40 = P4.0 MSP430FR5739 Pin 15, DLP-2232MSPF module Pin J1.23
0x41 = P4.1 MSP430FR5739 Pin 16, DLP-2232MSPF module Pin J1.24

PORT J:

0x50 = PJ.0/TDO MSP430FR5739 Pin 11, DLP-2232MSPF module Pin J1.10
0x51 = PJ.1/TDI MSP430FR5739 Pin 12, DLP-2232MSPF module Pin J1.9
0x52 = PJ.2/TMS MSP430FR5739 Pin 13, DLP-2232MSPF module Pin J1.12
0x53 = PJ.3/TCK MSP430FR5739 Pin 14, DLP-2232MSPF module Pin J1.11

The source code for the Token I/O firmware (developed using Code Composer) is available as a free download upon purchase and receipt of the hardware. Example Visual C++ source code developed using Microsoft Visual C for communicating with the DLP-2232MSPF via the Token I/O firmware is also available for download.

5.1 TOKEN I/O COMMAND SET

0x27 – Ping – Host Notification

Length: 2 Bytes
Parameters: None
Returns: 1 Byte: ASCII "F" or hex 0x46
Function: This function returns an ASCII "F" to tell the host that the module is up and running
Example: 0x02, 0x27 – Causes the module to return a 0x53 to the host

0x28 – Flash LED – Toggle the LED

Length: 2 Bytes
Parameters: None
Returns: 1 Byte: Command echo acknowledgement=0x28
Function: This function will cause the module's green LED to flash briefly
Example: 0x02, 0x28 – Causes the LED to toggle briefly

0x29 – LED On/Off

Length: 3 Bytes
Parameters: 1 Byte: 0=Turn LED Off; 1=Turn LED On
Returns: 1 Byte: Command echo acknowledgement=0x29
Function: This function will turn the module's green LED on or off
Example: 0x03, 0x29, 0x01 – Turns on the LED

0x30 – Digital I/O Read/Write

Length:	4 or 5 Bytes
Parameters:	2 or 3 Bytes:

1. Port Selection – Select the desired MSP430FR5739 port pin (refer to the port list on the previous page)
2. Port Direction: 1=Input; 0=Output
3. Port Value if Byte 2 specifies Output

Returns:	2 Bytes for Input=Value on port pin; command echo acknowledgement=0x30
	1 byte for Output=command echo acknowledgement=0x30
Function:	This function will read from or write to the selected port pin
Example:	0x04, 0x30, 0x60, 0x00, 0x01 – Sets Port 6 Pin 0 high

0x40 – A/D Conversion

Length:	3 Bytes
Parameters:	Mode: 0=Single conversion, 1=Continuous conversions (~1 per second)

Note: Setting the ADC mode to continuous (1) starts an infinite loop. The ADC will perform a conversion approximately twice a second and report the result to the host. To exit, stop the code execution using the debugger, or reset the module by unplugging the USB cable and then reconnecting it.

Returns:	2 Bytes: The 10-bit voltage data; MSB first
Function:	This function will enable A/D conversion on the selected channel and ADC, pause 10uS, perform the A/D conversion and then return 2 bytes to the host (MSB first). Command 0x42 must have been previously called to configure the desired analog channel as an A/D input, and 0x43 / 0x44 must have been called to configure the voltage reference.
Example:	0x3, 0x40 0x00 – Performs the A/D conversion and, using ADC0, returns 2 bytes of data followed by an echo of the command byte sent.

0x41 – Disable A/D

Length:	2 Bytes
Parameters:	None
Returns:	1 Byte: command echo acknowledgement=0x41
Function:	This function disables the A/D converter
Example:	0x2, 0x41 – Disables A/D Converter

0x42 – Select A/D Input

Length: 3 Bytes
Parameters: 0x00=Select Input A0 (P1.0)
                0x01=Select Input A1 (P1.1)
                0x02=Select Input A2 (P1.2)
                0x03=Select Input A3 (P1.3)
                0x04=Select Input A4 (P1.4)
                0x05=Select Input A5 (P1.5)
                0x06=Select Input A6 (P1.6)
                0x07=Select Input A7 (P1.7)
                0x08=Select Input Veref+
                0x09=Select Internal Input Vref-/Veref-
                0x0A=Select Internal Temperature Diode
                0x0B=Select Internal Input (Avcc – Avss)/2
Returns: 1 Byte: command echo acknowledgement=0x42
Function: This function selects the analog input to be used by the specified A/D converter
Example: 0x3, 0x42 0x03 – Selects Analog Input A3

0x43 – Select Reference Source

Length: 3 Bytes
Parameters: 0x00=Select Reference AVCC & AVSS
                0x01=Select Reference VREF & AVSS (refer to command 0x44 to configure VREF)
                0x02=Select Reference VEREF+ buffered & AVSS
                0x03=Select Reference VEREF+ & AVSS
                0x04=Select Reference AVCC & VEREF-
                0x05=Select Reference VREF & VEREF- (refer to command 0x44 to configure VREF)
                0x06=Select Reference VEREF+ buffered & VEREF-
                0x07=Select Reference VEREF+ & VEREF-
Returns: 1 Byte: command echo acknowledgement=0x43
Function: This function sets the A/D and D/A references to be external
Example: 0x2, 0x43, 0x01 – Select the Internal Voltage Reference VREF as the source

0x44 – Internal Reference Voltage
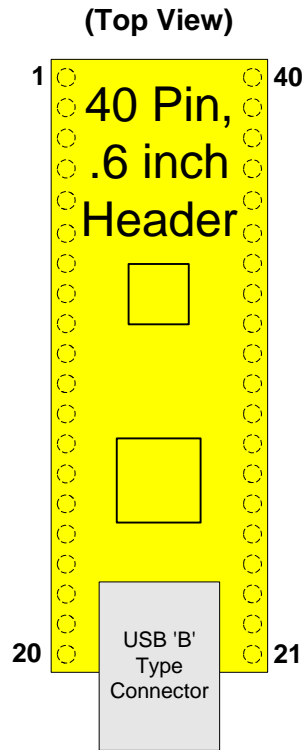
Length: 3 Bytes
Parameters: 0 = +1.0V; 1 = +2.0V; 2 = +2.5V
Returns: 1 Byte: command echo acknowledgement=0x44
Function: This function sets the A/D and D/A references to be internal; use command 0x50 to
                select the Internal Voltage Reference value
Example: 0x2, 0x44, 0x01 – Select Internal Voltage Reference of +2.0V
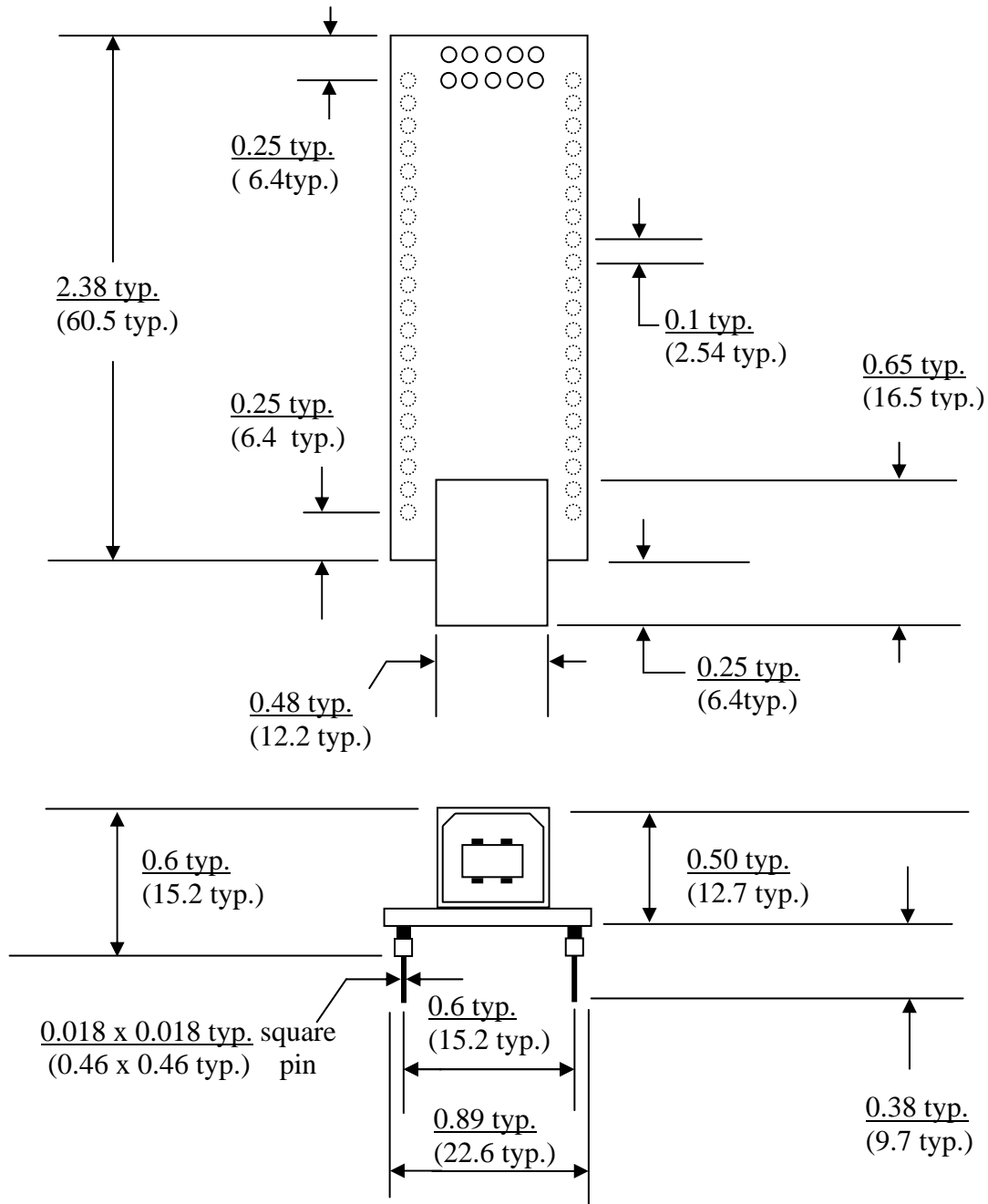
TABLE 1: DLP-2232MSPF PINOUT DESCRIPTION

(Top View)

PIN #	DESCRIPTION
1	**P1.1/A1/VeREF+** (I/O) Port 1 Pin 1 connected to the MSP430FR5739 Digital I/O P1.1, Analog Input 1 and the positive External Voltage Reference input
2	**P1.0/A0/VeREF-** (I/O) Port 1 Pin 0 connected to the MSP430FR5739 Digital I/O P1.0, Analog Input 0 and the negative External Voltage Reference input
3	**GROUND**
4	**P1.2/A2** (I/O) Port 1 Pin 2 connected to the MSP430FR5739 Digital I/O P1.2 and Analog Input 2
5	**P1.3/A3** (I/O) Port 1 Pin 3 connected to the MSP430FR5739 Digital I/O P1.3 and Analog Input 3
6	**P1.4/A4** (I/O) Port 1 Pin 4 connected to the MSP430FR5739 Digital I/O P1.4 and Analog Input 4
7	**P1.5/A5** (I/O) Port 1 Pin 5 connected to the MSP430FR5739 Digital I/O P1.5 and Analog Input 5
8	**GROUND**
9	**PJ.1/TDI** (I/O) Port J Pin 1 connected to the MSP430FR5739 Digital I/O PJ.1 and the JTAG Test Data Input
10	**PJ.0/TDO** (I/O) Port J Pin 0 connected to the MSP430FR5739 Digital I/O PJ.0 and the JTAG Test Data Output
11	**PJ.3/TCK** (I/O) Port J Pin 3 connected to the MSP430FR5739 Digital I/O PJ.3 and the JTAG Test Clock
12	**PJ.2/TMS** (I/O) Port J Pin 2 connected to the MSP430FR5739 Digital I/O PJ.2 and the JTAG Test Mode Select
13	**GROUND**

14	**P3.2/A14** (I/O) Port 3 Pin 2 connected to the MSP430FR5739 Digital I/O P3.2 and Analog Input 14
15	**P3.3/A15** (I/O) Port 3 Pin 3 connected to the MSP430FR5739 Digital I/O P3.3 and Analog Input 15
16	**P3.1/A13** (I/O) Port 3 Pin 1 connected to the MSP430FR5739 Digital I/O P3.1 and Analog Input 13
17	**P3.0/A12** (I/O) Port 3 Pin 0 connected to the MSP430FR5739 Digital I/O P3.0 and Analog Input 12
18	**GROUND**
19	**EXTVCC** (In) Use for applying main power (4.4-5.25 volts) to the module; connect to PORTVCC if the module is to be powered by the USB port (typical configuration)
20	**PORTVCC** (Out) Power from USB port—Connect to EXTVCC if the module is to be powered by the USB port (typical configuration); 500mA is the maximum current available to the DLP-2232MSPF and target electronics if the USB device is configured for high power
21	**VCCUSB** (Out) Power from EXTVCC (Pin 20) through the on-board filter
22	**GROUND**
23	**P4.0** (I/O) Port 4 Pin 0 connected to the MSP430FR5739 Digital I/O P4.0
24	**P4.1** (I/O) Port 4 Pin 1 connected to the MSP430FR5739 Digital I/O P4.1 and the module's on-board LED
25	**GROUND**
26	**P2.2** (I/O) Port 2 Pin 2 connected to the MSP430FR5739 Digital I/O P2.2
27	**GROUND**
28	**P3.4** (I/O) Port 3 Pin 4 connected to the MSP430FR5739 Digital I/O P3.4
29	**P3.6** (I/O) Port 3 Pin 6 connected to the MSP430FR5739 Digital I/O P3.6
30	**P3.5** (I/O) Port 3 Pin 5 connected to the MSP430FR5739 Digital I/O P3.5
31	**P3.7** (I/O) Port 3 Pin 7 connected to the MSP430FR5739 Digital I/O P3.7
32	**RESETMSPn** (Active Low Input) connected to the active low /RST pin of the MSP430FR5739. This input is pulled high on the module.
33	**GROUND**
34	**P1.7/A7** (I/O) Port 1 Pin 7 connected to the MSP430FR5739 Digital I/O P1.7 and Analog Input 7
35	**P1.6/A6** (I/O) Port 1 Pin 6 connected to the MSP430FR5739 Digital I/O P1.6 and Analog Input 6
36	**GROUND**
37	**P2.7** (I/O) Port 2 Pin 7 connected to the MSP430FR5739 Digital I/O P2.7
38	**P2.3/A6** (I/O) Port 2 Pin 3 connected to the MSP430FR5739 Digital I/O P2.3 and Analog Input 6
39	**P2.4/A7** (I/O) Port 2 Pin 4 connected to the MSP430FR5739 Digital I/O P2.4 and Analog Input 7
40	**GROUND**

6.0   MECHANICAL DRAWINGS (PRELIMINARY) INCHES (MILLIMETERS) UNLESS OTHERWISE NOTED

0.25 typ.
(6.4 typ.)

2.38 typ.
(60.5 typ.)

0.25 typ.
(6.4 typ.)

0.1 typ.
(2.54 typ.)

0.65 typ.
(16.5 typ.)

0.48 typ.
(12.2 typ.)

0.25 typ.
(6.4 typ.)

0.6 typ.
(15.2 typ.)

0.50 typ.
(12.7 typ.)

0.018 x 0.018 typ. square
 (0.46 x 0.46 typ.)   pin

0.6 typ.
(15.2 typ.)

0.89 typ.
(22.6 typ.)

0.38 typ.
(9.7 typ.)

7.0 DISCLAIMER

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This product and its documentation are supplied on an as-is basis, and no warranty as to their suitability for any particular purpose is either made or implied. DLP Design will not accept any claim for damages whatsoever arising as a result of use or failure of this product. Your statutory rights are not affected.
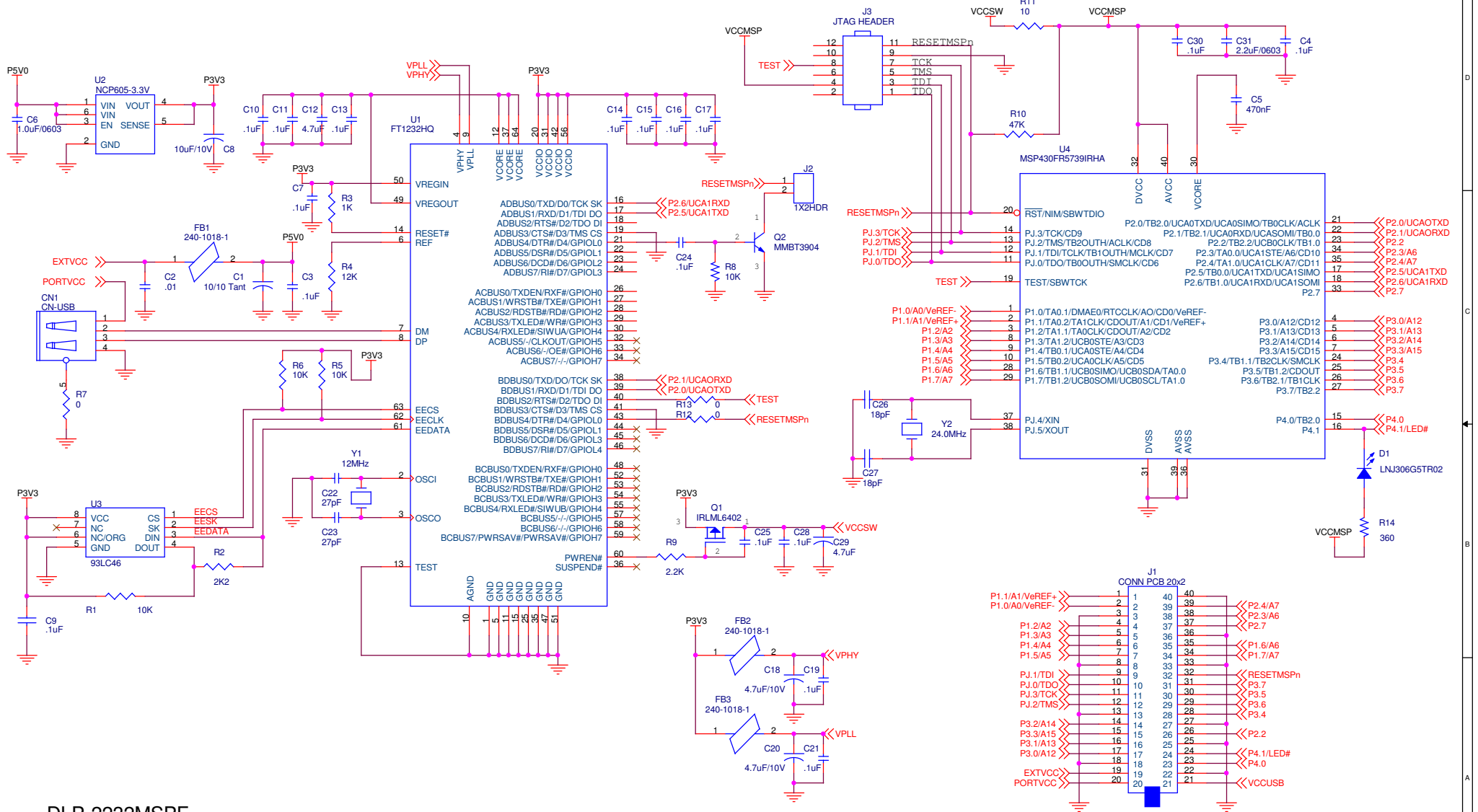
This product or any variant of it is not intended for use in any medical appliance, device or system in which the failure of the product might reasonably be expected to result in personal injury.

This document provides preliminary information that may be subject to change without notice.

8.0 CONTACT INFORMATION

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DLP-2232MSPF

v1.0